Architecture, Requirements, and Software: A Cooperative Approach to Product Management

Jonathan Casey

Mark Minnucci

Abstract # 3919

Raytheon

Integrated Defense Systems

Presentation Overview

- FBX-T Program Overview
- FBX-T Architecture/Requirements Goals
- FBX-T Teams
- Collaboration
- Six Sigma Background
- Architecture Phases
- Customer Benefits
- Summary

FBX-T Program Overview

- **FBX-T Radar Summary**
  - Multi-function, X-band, high resolution, phased-array radar
  - Derived from Terminal High Altitude Area Defense (THAAD) system radar component
  - Provides a forward-deployed sensor capability to C2BMC; acquires, tracks, and discriminates objects to be engaged by the Ballistic Missile Defense System (BMDS)
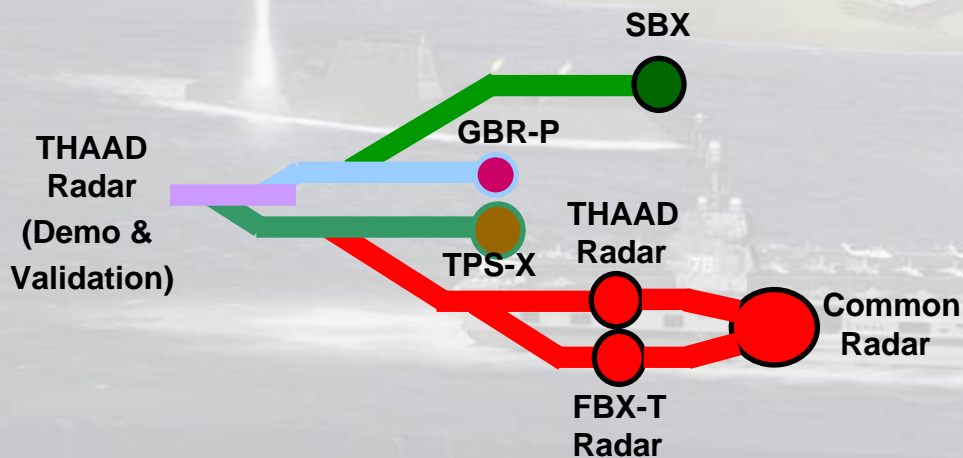
- **Current Status**
  - Spiral 1 (CR1) Operational Deployment to Japan (July 2006)
  - Spiral 2 (CR2) Software Requirements Complete (August 2006)
  - Spiral 2 (CR2) Internal Software Delivery (January 2007)

FBX-T Architecture / Requirements Goals

- **Understand THAAD Architecture**
- **Derive FBX-T Architecture**
- **Identify Changes to Baseline (THAAD) Requirements and Code**
- **Develop Common X-Band Family of Radar Baseline**

THAAD

GBR-P XBR

TPS-X

SBX

FBX-T

SBX

GBR-P

THAAD Radar (Demo & Validation)

TPS-X

THAAD Radar

FBX-T Radar

Common Radar

System Architecture Team

- **Charter**
  - "To understand and capture the behaviors of the FBX-T System, to aid in the development of robust requirements, to facilitate communication among stakeholders and to achieve seamless integration with the software development team."

- **Products**
  - ConOps
  - System Architecture Diagrams
  - Architecture Description Document (ADD)

- **Tools**
  - Popkin System Architect
  - Rational Rose
  - Rational ClearCase
  - Telelogic DOORS
  - iTracker

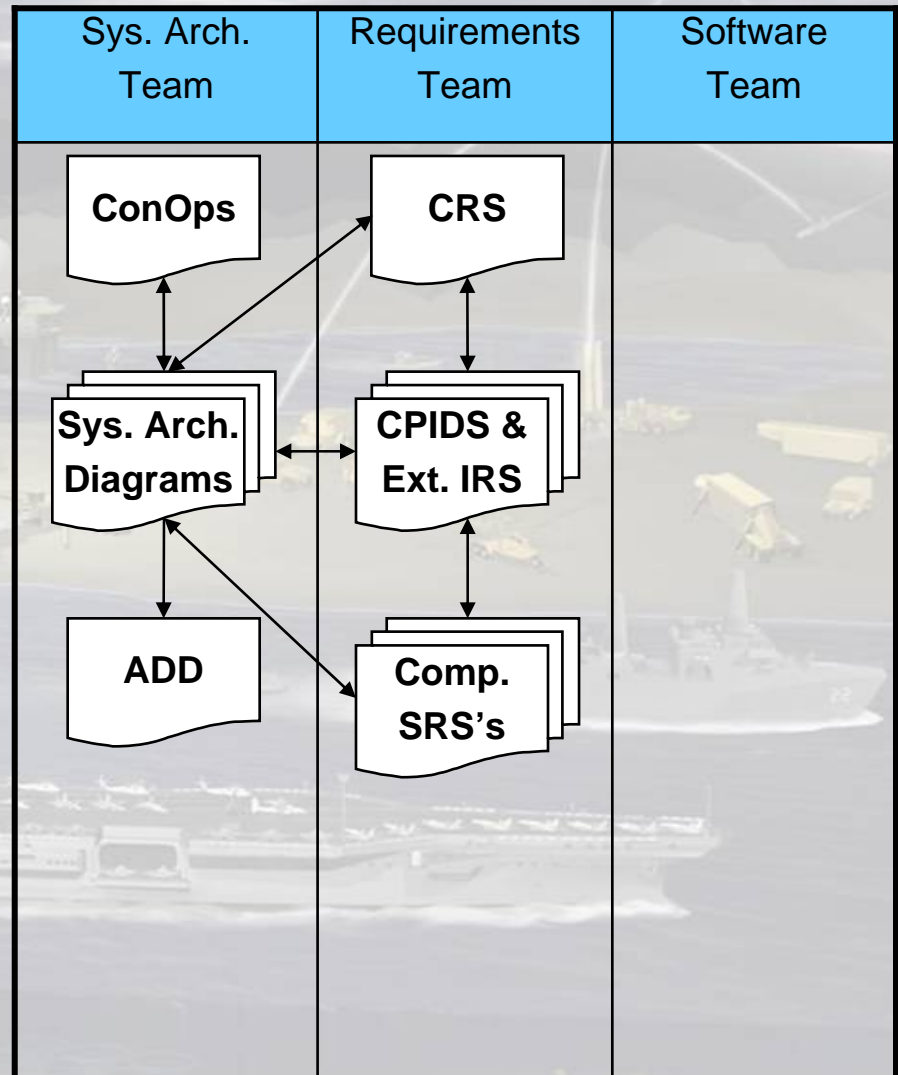| Sys. Arch. Team	Requirements Team	Software Team
ConOps		
Sys. Arch. Diagrams		
ADD		
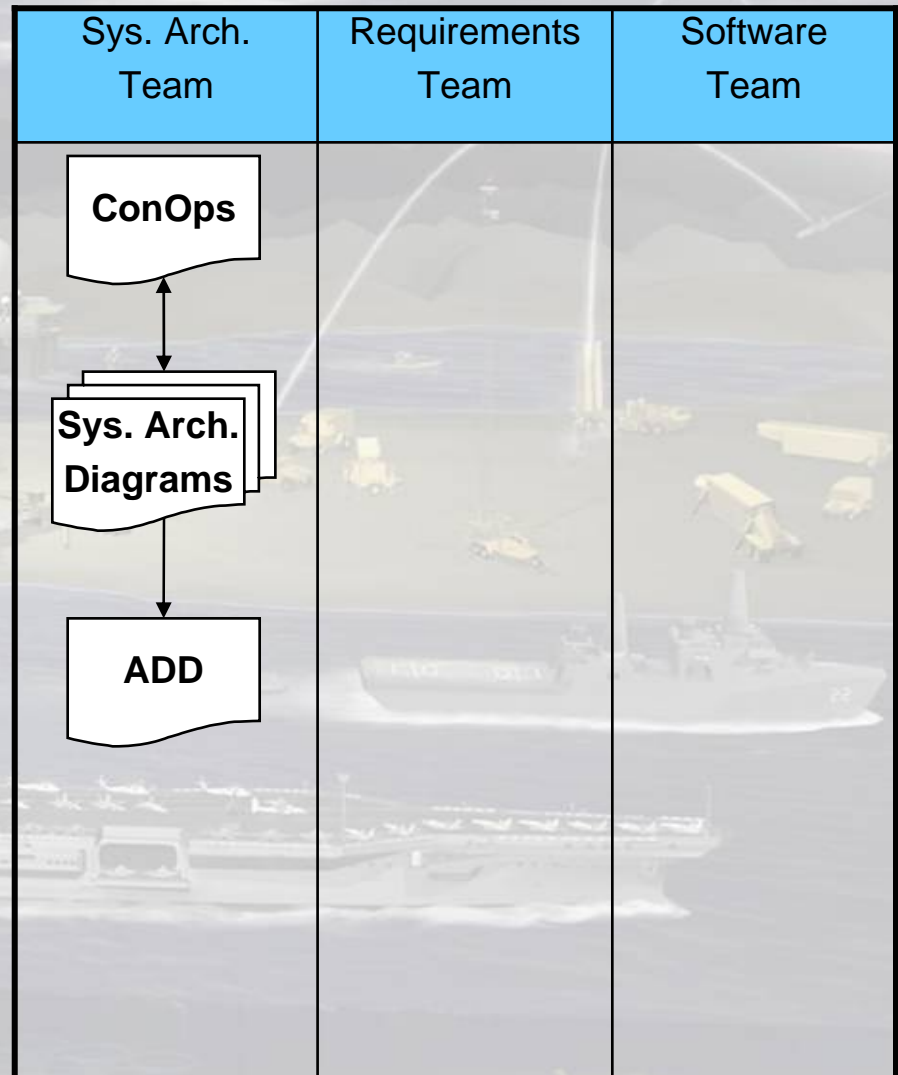
Requirements Team

- **Charter**
  - "To incorporate changes into legacy requirements documentation, translate new algorithms into software requirements, identify and resolve out-of-phase defects, and achieve seamless integration with the software development team."

- **Products**
  - Common Radar Specification (CRS)
  - Common Prime Item Development Specification (CPIDS)
  - External Interface Specification (Ext. IRS)
  - Component (Software) Requirements Specifications (SRS's)

- **Tools**
  - Rational Rose
  - Rational ClearCase
  - Telelogic DOORS
  - iTracker

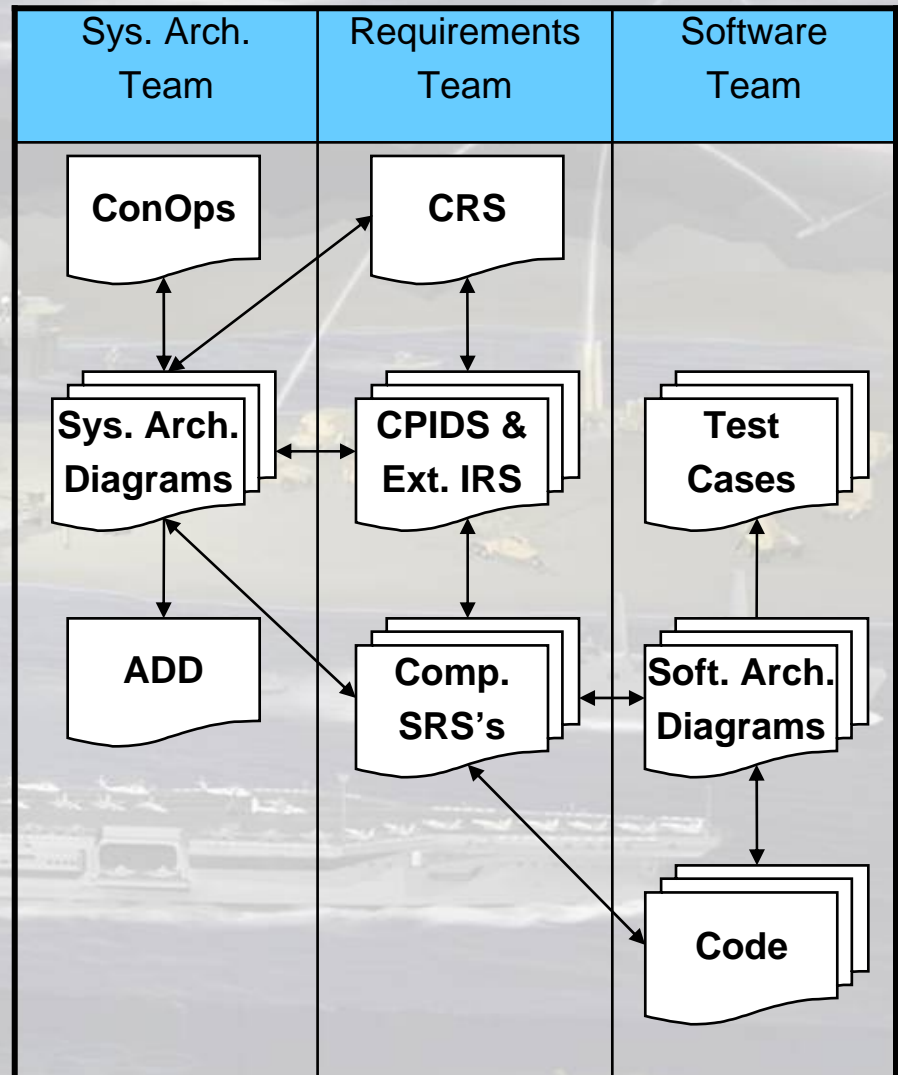| Sys. Arch. Team	Requirements Team	Software Team
ConOps	CRS	
Sys. Arch. Diagrams	CPIDS & Ext. IRS	
ADD	Comp. SRS's	

Software Development Team

- **Charter**
  - "To perform unit coding, testing, and software level integration according to system level architecture and software requirements specifications."

- **Products**
  - Software Architecture Diagrams
  - Tactical Code
  - Test Cases

- **Tools**
  - Rational Rose
  - Rational ClearCase
  - ADA
  - C++
  - iTracker

Sys. Arch. Team	Requirements Team	Software Team
ConOps	CRS	
Sys. Arch. Diagrams	CPIDS & Ext. IRS	Test Cases
ADD	Comp. SRS's	Soft. Arch. Diagrams
		Code

Collaboration

- **Teams are Aligned to Products**
- **Teams Collaborate:**
  - Shared Review Processes
  - Shared Configuration Management Processes
  - Shared Development Models
  - Common Toolsets

| Sys. Arch. Team	Requirements Team	Software Team
DOORS		
Rational Rose		
Rational ClearCase		
iTracker		

Six Sigma Background

- **Issues with FBX-T Architecture**
  - Lack of standardized process for product development and maintenance
  - No methodology exists for consistently flowing changes throughout products
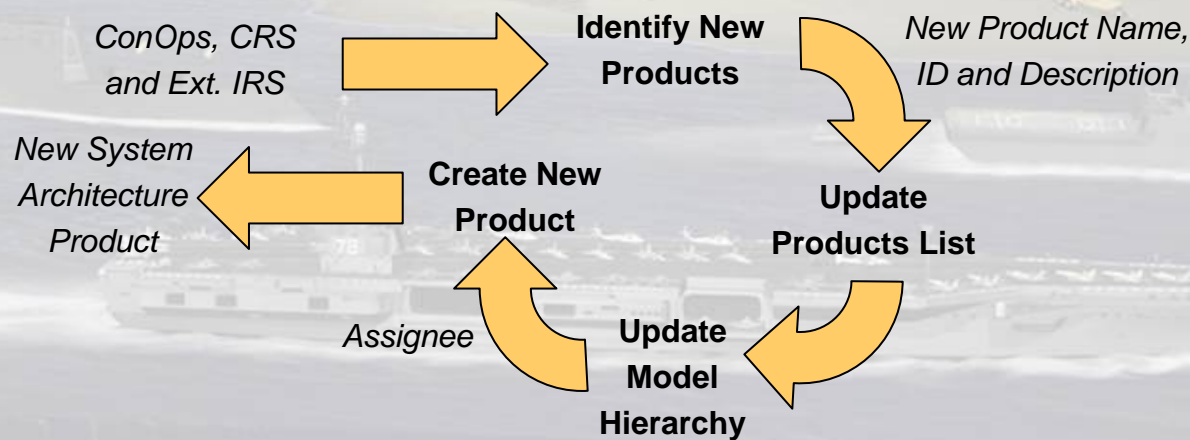 - Products maintained in a disorganized model

- **Vision Statement**
  - By introducing Configuration Management into all phases of an Architecture product's lifecycle, the FBX-T Radar program has created a methodology that will address the program's issues, and serve as a baseline for other Raytheon Architecture efforts.

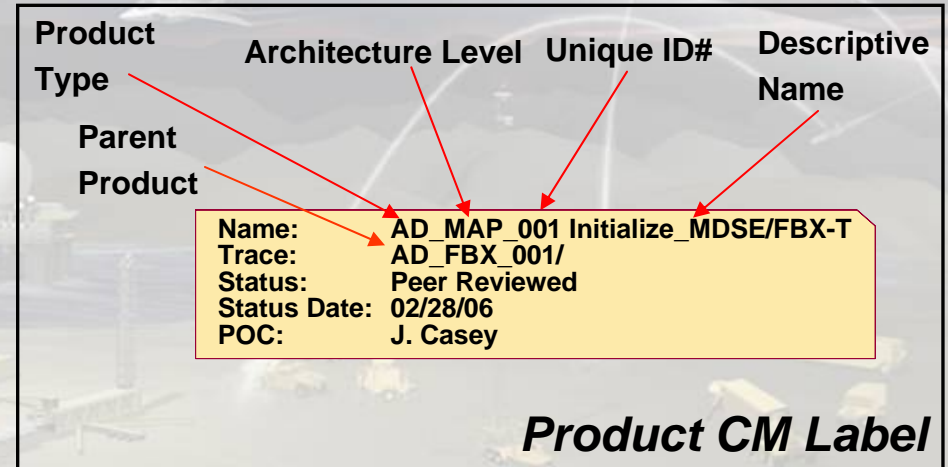| Development Phase	Review Phase	Change Phase
CM	CM	CM
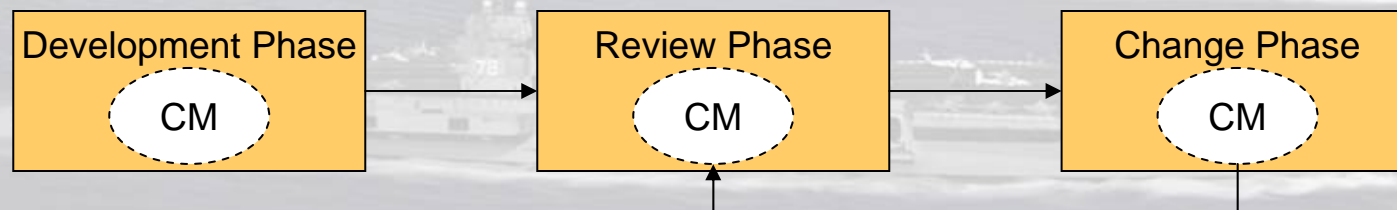
Architecture Development Phase Overview

- **Process**
  - Identify products to be introduced in architecture model baseline *(Architecture Lead & Chief Systems Engineer)*
  - Update products list *(Architecture Lead)*
  - Update model hierarchy *(Architecture Lead and Architecture Team)*
  - Create new product in model *(Architecture Team)*

ConOps, CRS and Ext. IRS → **Identify New Products**

New Product Name, ID and Description

Update Products List

Update Model Hierarchy

Assignee

Create New Product

New System Architecture Product

Architecture Development Phase Improvements

- **BMDS Architecture Products List**
  - Complete product history
- **Defined Model Hierarchy**
  - Aligns to architecture levels
- **CM Info Placed on all Products**
  - Diagram Status/Identification Box
- **Common Naming Convention for Diagrams**

Product Type
Parent Product
Architecture Level   Unique ID#   Descriptive Name

```
Name:         AD_MAP_001 Initialize_MDSE/FBX-T
Trace:        AD_FBX_001/
Status:       Peer Reviewed
Status Date:  02/28/06
POC:          J. Casey
```

Product CM Label

Architecture Products List

ID	Name	Tool	POC	Status	Date	Comment	WSTR
AD_MAP_001	Perform Discrimination	Rational Rose	J. Casey	Draft	02/07/06	Product Identified	N/A
AD_MAP_001	Perform Discrimination	Rational Rose	J. Casey	Peer	02/28/06	Peer Review Complete	N/A
AD_MAP_001	Perform Discrimination	Rational Rose	J. Casey	V01	03/15/06	ARB Review Complete	56, 60

Architecture Development Phase Improvements (Cont.)

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Model Hierarchy

Model Hierarchy

Architecture Level

OV-02/SV-01 Nodes

Use Case

Activity/Sequence
Diagrams

OV-02/SV-01 Diagram

Architecture Review Phase Overview

- **Process**
  - Architecture Team Lead Review *(Author and Architecture Lead)*
    - Common diagramming practices
    - Initial product goal
  - Architecture Team Review *(Author and Architecture Team)*
    - Consistency with related products
    - Dependencies between products
  - Peer Review *(Author, Subject Matter Experts, Stakeholders)*
    - Product quality
    - Technical Correctness
  - Architecture Review Board (ARB) Review *(Author and ARB Members)*
    - Baseline Architecture Model
    - Customer Requirements

New Product → **Architecture Team Lead Review** → *Draft Product* → **Architecture Team Review** → *Final Draft Product* → **Peer Review** → *Peer Approved Products* → **ARB Review** → *Approved Architecture Baseline*
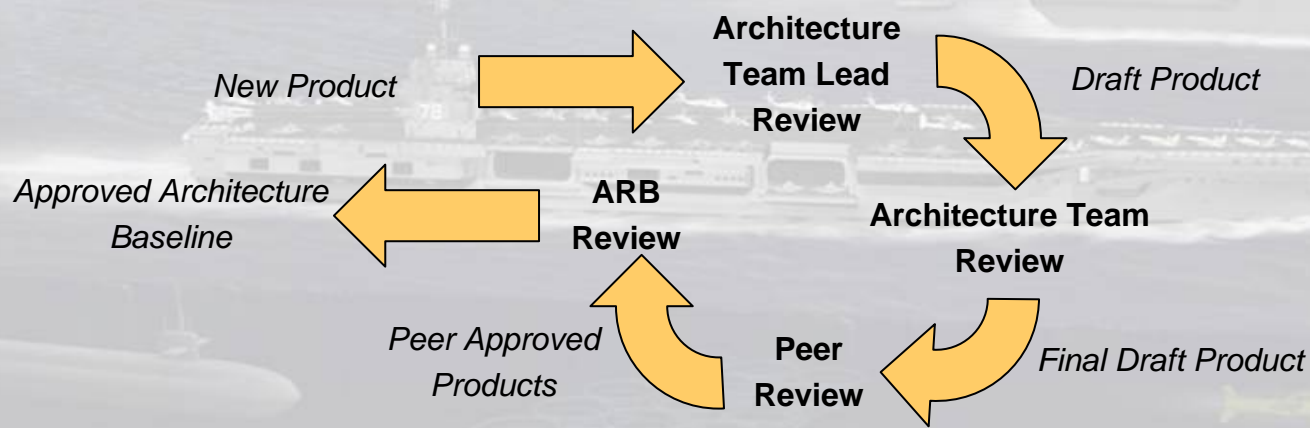
Architecture Review Phase Improvements

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- **Enhanced Review Cycle**
  - Introduced Architecture Review Board as approving authority
- **Assign Product Status**
  - Draft, Peer, ARB (Approved by ARB)
- **Affected Products Matrix**
  - Defines Relationships between products
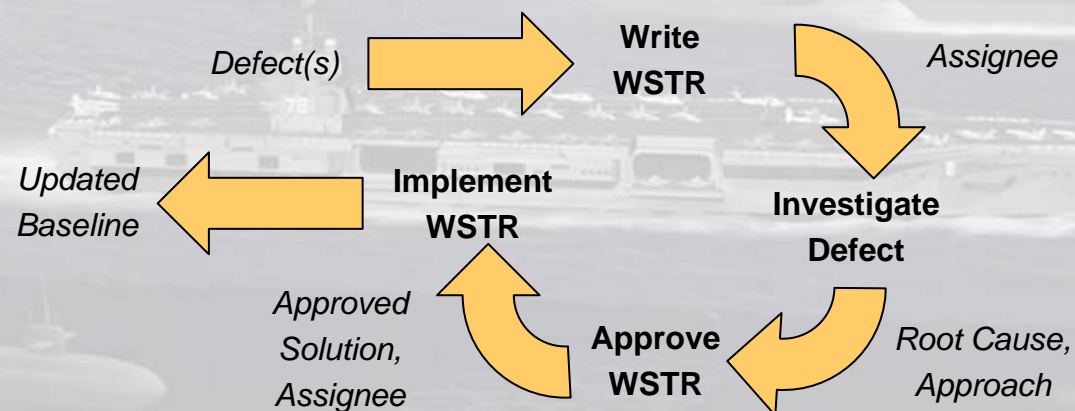- **Review Cycle Checklists**

Affected Products Matrix

		Product ID			
		AD_FBX_001	AD_MAP_001	AD_MAP_002	AD_MAP_003
Product ID	AD_FBX_001		PC	PC	PC
	AD_MAP_001	PC		IO	IO
	AD_MAP_002	PC	IO		IO
	AD_MAP_003	PC	IO	IO	

Legend: PC – Diagrams have a Parent/Child relationship
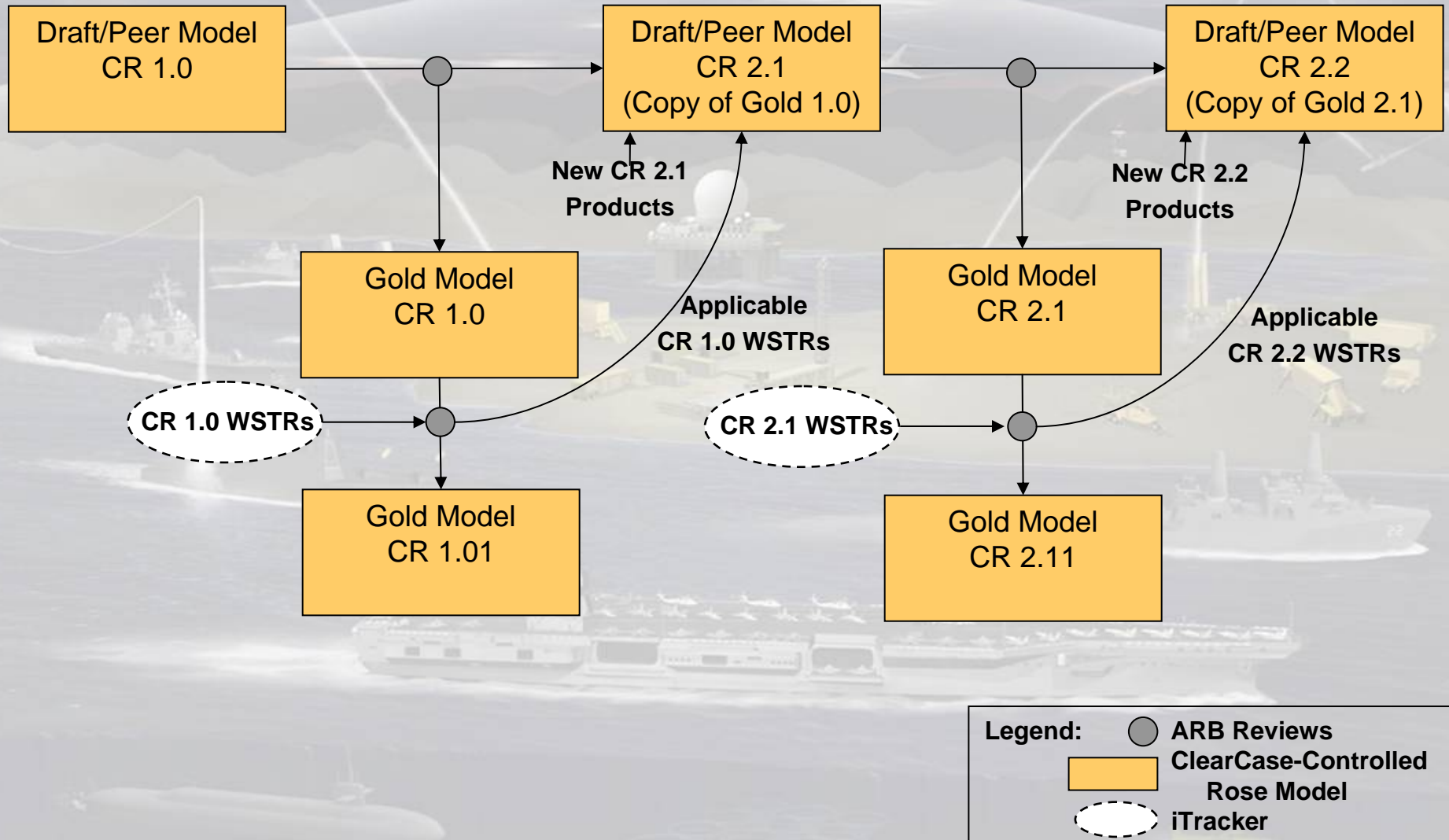IO – Diagrams have an Input/Output relationship

Architecture Change Phase Overview

- **Process**
  - Write Web System Trouble Report (WSTR) *(FBX-T Team Member)*
    - Description of defect
    - Identify affected product
  - Investigate Defect *(Architecture Team Member)*
    - Subject matter experts
    - Identify additional affected products and models
  - Approval of WSTR Approach *(Architecture Lead and Architecture Review Board)*
    - Presentation of problem and suggested approach
    - Program implications
  - Implementation of WSTR *(Architecture Team Member and Architecture Lead)*
    - *Update Baseline (Gold Copy)*
    - *Verify*

Defect(s) → **Write WSTR** → *Assignee* → **Investigate Defect** → *Root Cause, Approach* → **Approve WSTR** → *Approved Solution, Assignee* → **Implement WSTR** → *Updated Baseline*

Architecture Change Phase Improvements

Customer Benefits

- **Internal Customer (Architecture, Requirements, Software teams)**
  - Internal Deliveries Ahead of Schedule
  - Improves Synergy
  - Phase overlap allows for shortened development cycle
  - Versatile team members work on all parts and phases of system

- **External Customer (Missile Defense Agency)**
  - Consistent Program rating of "Excellent"
  - Award fee's of 98% - 100%
  - Fewer out of phase defects
  - "No Doubt" in Raytheon's ability to achieve the mission

Summary

- **The processes from this presentation are tool and domain independent and can be implemented on programs of all sizes**

- **Configuration Management fails if teams do not collaborate**

- **Common models, tools, and processes provide insight between Systems and Software Engineering teams**

Questions?

Thank you for your time!

Author Bios

- **Mr. Casey is a Systems Engineer with 2 years of service with Raytheon. He began his Raytheon career on the FBX-T Radar Program, developing system requirements and architecture products for the External Communications Program (XCP). Currently, Jonathan supports the Mission Application Program (MAP) requirements and architecture efforts and is the Display and Controls Program (DCP) requirements lead. Jonathan holds a Bachelor's Degree in Electrical and Computer Engineering from Worcester Polytechnic Institute (WPI), and is working towards a Masters Degree in Technological Innovation from WPI. He can be reached at (339) 645-8135 or by email at Jonathan_E_Casey@raytheon.com**

- **Mr. Minnucci is a Systems Engineer who has 1 year of service at Raytheon. He began his Raytheon career on the FBX-T Radar Program, developing System Architecture products and processes. Currently, Mark is the Architecture Lead for the Missile Defense System Exerciser (MDSE) program. He is responsible for the planning, development and delivery of the MDSE Program's Architecture. Prior to joining Raytheon, Mark spent 2 years supporting System Architecture efforts at Lockheed Martin – Integrated Defense Systems, in Valley Forge, Pennsylvania. Mark holds a Bachelor's Degree in Electrical Engineering from Villanova University, and is working towards a Master's Degree in System Design and Management from the Massachusetts Institute of Technology. Mark can be reached by phone at (339)-645-6681 or by e-mail at mark_minnucci@raytheon.com.**